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STUDIES ON THE LIGHT SENSITIVITY OF PLANTAGO MAJOR L. SEEDS

II. THE EFFECT OF RED LIGHT ALONE AND MEDIATED BY CHEMICALS

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Introduction

In an earlier contribution (Rezk, 1968), the effect of gibberellin, kinetin, and potassium nirate solutions on the germination in the dark of the light — sensitive seeds of Plantago major has been investigated. It has been shown in that part of the work that gibberellic acid only could promote the dark germination of those seeds, while the other two chemical substances could not. It is yet always convenient to think of promoting the germination of such light — sensitive seeds by exposing them to irradiation from red light sources for varying periods of time. This promoting effect of red light is reported to be reversible by a subsequent irradiation with far-red light (Bortwick, et al., 1954; Downs, 1955; Alcorn, et al., 1959; Kahn, 1960; Ikuma, et al., 1960; Mohr, et al., 1963; and Mc Donough, 1965...).

A combination of either kinetin or potassium nitrate solutions with red light was thought to promote the germination in the dark of those seeds. Such combinations were previously tried by many other authors. Thus, Toole et al. (1955) could promote the germination of different light-sensitive seeds (e.g. *Lepilium densiflorum)* using 0.2 % KNO_3 solution only after irradiating them with red light. Khan and Tolbert (1965) came to the conclusion that neither kinetin nor red light alone were able to reverse the inhibitory effect of coumarin and xanthatin on seed germination, but only a combination of both treatments was able to reverse this inhibitory effect.

Thus the effect of red light alone and in combination with either kinetin or potassium nitrate solutions on the dark germination of *Plantago major* seeds was experimented here.

Materials and Methods

Irradiation with red light.

Red light was provided from an iodine lamp (T u n g s r a m, 1000 Watt), the light of which was passed through a glass basin containing water to avoid heating of the plant material and then through a metal interference filter (C a r l Z e i s s, Jena) of 650 mμ. The intensity of the delivered red light was measured by the technique of H o r v á t h and S z á s z (1965), and was found to be 3400 erg/cm^2/sec.

Fifty seeds were sown in each 9 cm. Petri-dish on two thicknesses of filter paper wetted with 6 ml. of distilled water. The seeds were imbibed in the dark for 24 hours before exposure to red light. Irradiation with red light was carried out for any of the following periods: 2, 5, 10, 20, 30, 40, 50, or 60 minutes. There were 200 seeds distributed in four Petri-dishes exposed to red light for each of these time intervals. Attention was paid that the temperature at the seed level did not change during irradiation. After irradiaton for the desired time period, the seeds were returned back to the dark inside an incubator in which the temperature was controlled at 25 ± 1 C° C for 10 hours by day and at $20 \pm 1°$ C for 14 hours by night daily. A control of unirradiated seeds was simultaneously run. After 15 days of dark incubation of the seeds were examined for the germination percentages. The experiment was repeated twice thus having eight dishes irradiated for each of the mentioned time intervals. For the sake of comparison, red light from fluorescent lamps of the intensity of 10,000 erg/cm^2/sec was used in irradiating 200 seeds for one hour after having been imbibed in distelled water for 24 hours.

For the study of the effect of kinetin and potassium nitrate solutions mediated with red light, the seeds were imbibed in the test solution for 24 hours before being exposed to red light as described above.

Five concentrations of kinetin solutions were prepared (1, 10, 20, 50, and 100 p.p.m.) in distilled water.

Potassium nitrate solution used was a 0.2 % solution of the analytical reagent.

For each treatment four hundred seeds were sown in the manner described before. The seeds were first imbibed in the test solution for 24 hours in the dark and then exposed to red light from either sources for one hour. After irradiation, the dishes were returned back to the dark incubator under the same conditions previously described.

Results and Discussion

From table I it is clear that neither red light from the interference filter nor from the flurescent lamps had any stimulatory effect on the germination in the dark of *Plantago major* seeds irrespective of the period of exposure.

The response of the seeds to irradiation with red light from either sources is in contrast to that arrived at by many other authors working on many light-sensitive seeds. For example, A l c o r n et al., (1956) could stimulate the dark germination of the light sensitive *Carnegiea gigantea* seeds by irradiating them with red light for 30 minutes. T o o l e et al. (1955) gave a list of some light-sensitive seeds the dark germination of which was promoted by red light. Lettuce seeds *(Lactuca sativa* var. *Grand Rapids)* and several other varieties were the field of many researches due to their light-sensitivity and due to that they responded by germanition in the dark if they were irradiated with red light. The germination promotion was found to increase with the

Table I. Effect of exposing the seeds of *Plantago major* to red light from two different sources for varying time periods, on their germination in the dark.

Time of exposure to red light (min.)	Germination Percentage
2	3.0
5	2.5
10	2.0
20	3.0
30	3.5
40	3.5
50	3.5
60	4.5
Red light from fluorescent lamps for one hour	4.0
Dark Control	4.0

increase of the exposure period to red light (Borthwick et al., 1954; Kahn, 1960; Ikuma and Thimann, 1960).

More important in this respect is the reported similarity of the action of kinetin and red light as viewed by Miller (1956 and 1958). The only difference in Miller's results was that far-red light reversed only partially the effect of kinetin while it completely reversed that of red light. Powell and Griffith (1960) have reported a similarity in the action of red light and kinetin as both increased the

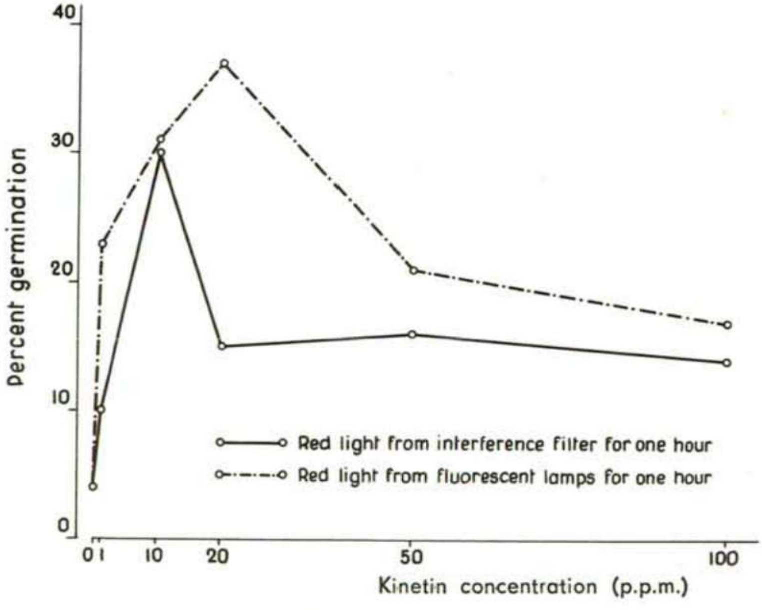

Fig. 1. Effect of kinetin concentrations mediated with two different types of red light on the germination in the dark of the seeds of *Plantago major*.

expansion of discs from bean leaves and both caused greater elongation in stems and petioles of bean seedlings. They added that the action of red light and kinetin together caused a greater increase in size of discs, but kinetin has never physiologically replaced red light.

In our results here there is a parallel similarity in action between red light and kinetin. Both of these two factors failed to promote the dark germination of the seeds of *Plantago major*.

The combination of red light and kinetin gave results that are graphically represented in Fig. 1. It is clear from that figure that kinetin solutions mediated with red light from either sources could promote the germination of *P. major* seeds, but the promotions were higher on using red light from the fluorescent lamps. This difference in response to the different qualities of red light may be attibutable to the higher intensity of red light received from fluorescent lamps. Similar germination promotions by the use of the combination of red light and kinetin have been arrived at by different authors. An example of the synergistic effect of the red light and kinetin was given by Khan and Tolbert (1965) who stated that the inhibitory effect of some naturally-occurring seed germination inhibitors (coumarin and xanthatin) could be reversed only by a combination of red light and kinetin but not by either of them alone.

With potassium nitrate the position was nearly the same as was with kinetin, a germination promotion was obtained when this salt at a concentration of 0.2 % was applied to the seeds in combination with red light from either sources. Table II shows the results of this experiment. It is again shown that the promotion was higher when red light was supplied from fluorescent lamps that it was when the source of red light was the iodine lamp with its interference filter.

Table II. The effect of KNO_3 solution alone and mediated with red light from two different sources on the germination of *Plantago major* seeds in the dark.

Seeds imbibed in 0.2% KNO_3 for 24 hours, and then ...	Germination Percentage
Red light from interference filter for one hour	29.30
Red light from fluorescent lamps for one hour	40.75
Dark Control	3.00

The results obtained with the germination of *Carnegiea gigantea* seeds by Alcorn et al. (1956) coincide greatly with our findings with *Plantago major* seeds here since those light-sensitive seeds were greatly promoted in germination only when subjected to a combined treatment with potassium nitrate solution and red light. Toole et al. (1955) also mentioned that *Lepidium densiflorum* and other light-sensitive seeds could only be promoted to germinate in the dark if they were supplied with potassium nitrate solution and irradiated with red light and they mentioned that germination was never initiated if the seeds were imbibed in potassium nitrate solution alone.

Summary

Red light from interference filter or from fluorescent lamps could not promote the germination of the light-sensitive seeds of Plantago major. A combination of red light with either kinetin or potassium nitrate solutions could promote the germination of those seeds in the dark. Irradiation with red light from fluorescent lamps in combination with either of these two chemical substances gave higher germination percentages than when red light from the interference filter was used.

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